AL/HR-TP-1993-0016

THE IDENTIFICATION OF ABILITY REQUIREMENTS AND SELECTION INSTRUMENTS FOR FIGHTER PILOT TRAINING

Thomas R. Carretta

HUMAN RESOURCES DIRECTORATE
MANPOWER AND PERSONNEL RESEARCH DIVISION
7909 Lindbergh Drive
Brooks Air Force Base, TX 78235-5352

Michael N. Rodgers, Lieutenant Commander

Canadian Forces Personnel Applied Research Unit
4900 Yonge Street
Willowdale, Ontario
Canada

Ivar Hansen

The Norwegian Armed Forces Psychological and Educational Centre
Mil/Akershus
Oslo, Norway
0015 Oslo 1

June 1993

Interim Technical Paper for Period January 1992 – August 1992

AIR FORCE MATERIEL COMMAND
BROOKS AIR FORCE BASE, TEXAS

ARMSTRONG LABORATORY

NOTICE

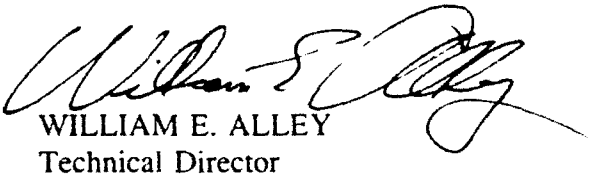
This technical paper is published as received and has not been edited by the technical editing staff of the Armstrong Laboratory.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

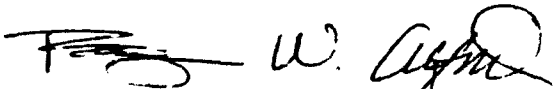
The Office of Public Affairs has reviewed this paper, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This paper has been reviewed and is approved for publication.

THOMAS R. CARRETTA
Project Scientist
Manpower & Personnel Research Div



WILLIAM E. ALLEY
Technical Director
Manpower & Personnel Research Div



ROGER W. ALFORD, Lt Colonel, USAF
Chief, Manpower & Personnel Research Div

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	June 1993	Interim – January 1992 – August 1992

4. TITLE AND SUBTITLE
The Identification of Ability Requirements and Selection Instruments for Fighter Pilot Training

5. FUNDING NUMBERS
PE – 62205F
PR – 7719
TA – 25
WU – 01

6. AUTHOR(S)
Thomas R. Carretta
Michael N. Rodgers
Ivar Hansen

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Armstrong Laboratory (AFMC)
Human Resources Directorate
Manpower and Personnel Research Division
7909 Lindbergh Drive
Brooks Air Force Base, TX 78235-5352

8. PERFORMING ORGANIZATION REPORT NUMBER
AL/HR-TP-1993-0016

9. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Forty-three experienced fighter pilots from Canada, Norway, and the United States served as subject matter experts (SMEs) in an effort to determine the relative importance of 27 personnel characteristics for fighter pilot performance. Inter-rater reliability estimates indicated an acceptable level of agreement for SMEs within each country and between pairs of countries regarding the relative importance of the 27 characteristics. Because there was sufficient agreement among SMEs from the three countries, the average ranking of the 27 characteristics was calculated. Based on these results, aviation psychologists from Canada, Denmark, the Netherlands, Norway, the United Kingdom, and the United States reviewed selection instruments currently in use in NATO member countries, to identify the most promising selection instruments for inclusion in a computer-based fighter pilot test battery. Their recommendations are summarized in the paper.

14. SUBJECT TERMS
Ability requirements
Fighter pilot training
Selection instruments

15. NUMBER OF PAGES
50

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

CONTENTS

CONTENTS (Continued)

TABLES

PREFACE

This paper documents a NATO Aircrew Selection Working Group (ACSWG) project to (a) identify critical ability requirements for successful performance in fighter aircraft and (b) to recommend a selection test battery to assess these critical abilities.

These authors thank the fighter pilots who served as subject matter experts in the ability analysis study. Appreciation also is extended to Maj Per Byrdorf, Dr Ferdinand Rameckers and Dr Gail Walker-Smith who served on the selection instrument review board.

THE IDENTIFICATION OF ABILITY REQUIREMENTS AND SELECTION INSTRUMENTS FOR FIGHTER PILOT TRAINING

SUMMARY

Forty-three experienced fighter pilots from Canada, Norway, and the United States served as subject matter experts (SMEs) in an effort to determine the relative importance of 27 personnel characteristics for fighter pilot performance. Inter-rater reliability estimates indicated an acceptable level of agreement for SMEs within each country and between pairs of countries regarding the relative importance of the 27 characteristics. Because there was sufficient agreement among SMEs from the three countries, the average ranking of the 27 characteristics was calculated. Based on these results, aviation psychologists from Canada, Denmark, the Netherlands, Norway, the United Kingdom, and the United States reviewed selection instruments currently in use in NATO member countries, to identify the most promising selection instruments for inclusion in a computer-based fighter pilot test battery. Their recommendations are summarized in the paper.

INTRODUCTION

Background

The early efforts of the Euro-NATO Aircrew Selection Working Group (ACSWG) included the development of two reference manuals. The first, referred to as the Red Book (ACSWG, 1983), provided an overview of member pilot candidate selection and screening procedures (i.e., computer-based testing, personality testing, basic predictors, flight screening). The second manual, the Black Book (ACSWG, 1988), provided detailed information regarding member selection instruments (i.e., general and technical characteristics, administration procedures, theoretical basis, technical evaluation). As of 1982 when the ACSWG was founded, the predominant pilot candidate selection factors within NATO included medical and physical fitness, academic performance, paper-and-pencil aptitude test scores, personality, and previous flying experience. Most countries reported no experience with computer-based tests and only Germany was using computer-based tests for operational selection in 1983 (ACSWG, 1983).

Purpose

One of the early goals of the ACSWG was to identify ability requirements for fighter pilots. This was accomplished through an ability analysis of fighter pilot tasks using a modified version of the Levine, Mallamad, and Fleishman (1978) decision-flow diagram. Following the completion of the ability analysis, ACSWG aviation psychologists reviewed pilot candidate selection instruments currently used by NATO member countries to recommend

a selection battery for fighter pilots. The purpose of this report is to document the results of the ability analysis and selection instrument review.

STUDY 1: ABILITY ANALYSIS

Method

Subjects

The subject matter experts (SMEs) in this study were 43 experienced fighter pilots from Canada (n = 18), Norway (n = 15), and the United States (n = 10). Their expert knowledge of the task requirements were crucial for identifying and ranking the abilities necessary for fighter pilots.

Procedure

SMEs performed an exercise to determine the importance of personnel characteristics for fighter pilot tasks using a modified version of the Levine, Mallamad, and Fleishman (1978) decision-flow diagram. With this technique, SMEs used a structured series of questions to determine the importance of characteristics for performing 12 job-related tasks. The tasks were chosen to be unique and critical to flying high-performance fighter aircraft. Thus, pilot tasks that are common to other types of aircraft (e.g., receive IFR clearance) were not included. Each SME rated the importance of 27 abilities and characteristics for performing each of the 12 job-related tasks. Definitions of the 27 abilities and characteristics are provided in Appendix A and the 12 pilot tasks are summarized in Appendix B.

Each SME was provided with a package containing the decision-flow diagram, 12 critical pilot tasks, and a set of instructions. Each SME was required to select a task, and while considering the task, work through the questions in the decision-flow diagram. Whenever the SME decided a characteristic was necessary for successful completion of the task under consideration, its importance was indicated on a five-point scale. Once all questions in the decision-flow diagram had been completed for a particular task, a new task was selected and the process repeated. Using this procedure, the SMEs independently rated the importance of each of the 27 characteristics for the performance of each of the 12 critical pilot tasks. For additional details regarding the decision-flow diagram and questionnaire, see Rodgers and Sage (1986).

Results

Inter-rater reliability estimates (i.e., consistency among SMEs) calculated separately for SMEs from each participating country, indicated an acceptable level of agreement for SMEs within each country (Canada, .91; Norway, .86; United States, .90). SMEs within each country tended to rank-order the 27 abilities in a similar manner in terms of their importance for performing in a fighter-type aircraft.

The mean score for each characteristic and its ranking for each group of SMEs are presented in Table 1. Examination of the mean scores for each characteristic across countries revealed significant differences for 23 of the 27 characteristics. SMEs from the United States ($\underline{M}$ - 3.65) consistently rated characteristics to be of greater importance than did SMEs from Canada ($\underline{M}$ = 2.90) or Norway ($\underline{M}$ = 2.20). It was not determined the extent to which these differences were due to response bias or to true differences in the perceived importance of these characteristics. The source of the mean differences was not considered important, as the purpose of the study was to determine the relative importance (i.e., ranking) of the 27 characteristics.

Within each country, characteristics were ranked from most to least important. Rank-order correlation coefficients (i.e., Spearman's rho) calculated for each pair of countries indicated substantial agreement regarding the relative importance of the 27 characteristics (Canada-Norway, .93; Canada-United States, .91; Norway-United States, .93). Because there was sufficient agreement among SMEs from the three countries, the average rankings of the 27 characteristics were calculated (see Table 1).

Discussion

The rating of the characteristics necessary for the successful performance of fighter pilot tasks was shown to be a reliable process for SMEs from each of the participating countries. Of greater importance was the high level of agreement regarding the relative importance of these characteristics across the three groups of SMEs. These results suggested that the ranking of the importance of the characteristics was coheremt (i.e., the most important characteristics can be clearly identified) and has important implications for the development of pilot candidate selection instruments. These results suggest that when constructing a pilot candidate selection battery, emphasis should be placed on measures of situational awareness (i.e., readiness to respond to situational changes), memorization (i.e., memory for numbers, procedures, etc.), and reasoning (i.e., combining information to form logical conclusions). Consideration should be given to developing measures of other characteristics in order of their relative importance as disclosed by the rankings.

TABLE 1. SUMMARY OF CHARACTERISTIC RANKINGS BY COUNTRY

Ability	Average Rank-Order	Mean and Rank-Order					
		Canada		Norway		USA	
		Mean	Rank	Mean	Rank	Mean	Rank
Situational Awareness	1.67	4.33	1	3.63	2	4.44	2
Memorization	2.33	4.04	2	3.73	1	4.42	4
Achievement Motivation	4.67	3.65	7	2.89	6	4.51	1
Reasoning	5.00	3.71	6	3.21	4	4.41	5
Perceptual Speed	5.33	3.72	5	3.17	5	4.37	6
Time Sharing	6.00	3.44	12	3.52	3	4.43	3
Aggressiveness	6.67	3.88	3	2.71	9	4.20	8
Selective Attention	7.33	3.64	8	2.84	7	4.29	7
Response Orientation	8.50	3.75	4	2.64	10	4.13	11
Spatial Orientation	9.00	3.53	9	2.77	8	4.14	10
Divided Attention	10.33	3.48	10	2.26	12	4.19	9
Emotional Stability	13.33	3.47	11	2.22	13	3.92	16
Psychomotor Coordination	13.33	3.30	15	2.53	11	3.95	14
Flexibility of Closure	14.17	3.13	16	2.08	15	4.12	12
Information Ordering	14.33	3.31	14	1.99	16	4.04	13
Risk Taking	14.67	3.39	13	2.15	14	3.89	17
Cooperativeness	16.67	2.42	18	1.89	17	3.94	15
Control Precision	18.83	2.53	17	1.66	21	3.59	18
Number Facility	20.33	2.37	19	1.85	18	2.70	24
Assertiveness	20.33	2.22	20	1.63	22	3.58	19
Visualization	20.50	2.21	21	1.78	19	3.21	22
Oral Comprehension	22.17	1.68	23	1.42	23	3.37	20
Rate Control	22.67	2.16	22	1.71	20	1.54	26
Oral Expression	23.17	1.67	24	1.14	25	3.35	21
Written Comprehension	24.00	1.43	25	1.19	24	3.00	23
Leadership	25.67	1.33	26	.69	25	2.52	25
Written Expression	27.00	.53	27	.14	27	1.23	27

These results were consistent with those from similar ability analyses conducted with fighter pilots from other NATO countries (ACSWG, 1987) and US Army helicopter pilots (McAnulty, 1987). In the ACSWG (1987) study, SMEs from Denmark, Germany, the Netherlands, and the United Kingdom rank-ordered a similar list of characteristics for the same 12 fighter-type tasks. The most important characteristics in descending order were situational awareness, spatial orientation, time sharing, aggressiveness, divided attention, psychomotor coordination, perceptual speed, selective attention, and visualization. The most notable difference between these results and those reported in Table 1, was that "memorization" was not among the most important characteristics identified in the ACSWG (1987) study. This may have been because a different definition of memorization was used in these two studies. In the ACSWG (1987) study, "memorization" emphasized long-term memory whereas the focus in this study was on short-term memory processes. Similar definitional differences occurred for the attributes "achievement motivation" and "assertiveness."

Despite marked differences in the performance characteristics of fixed-wing and rotary wing aircraft, McAnulty (1987) identified a similar set of crucial characteristics for helicopter pilots. The most important characteristics for primary and instrument helicopter training included perceptual speed, control precision, multilimb coordination, time sharing, arm/hand steadiness, oral comprehension, deductive reasoning, speed of closure, selective attention, choice reaction time, and spatial orientation.

The term "situational awareness" was not used explicitly in the McAnulty (1987) study. However, its components were included in the combination of "speed of closure" and "choice reaction time" abilities. In a similar manner, the characteristic "psychomotor coordination" was covered by the more specific characteristics of "multilimb coordination," and "arm/hand coordination."

Conclusion

Results from the current and previous studies suggest that a set of common characteristics are necessary for fixed wing and rotary wing pilots. Although some differences were noted between average rated fighter and helicopter pilot characteristics, selection test batteries for these two groups should have considerable overlap.

Based on these results, a pilot candidate selection test battery should include, at a minimum, measures of situational awareness, memorization, and reasoning. Measures of other characteristics should be targeted for inclusion to the extent to which they are expected to provide incremental validity (i.e., account for unique prediction of the criterion).

STUDY 2: SELECTION INSTRUMENT REVIEW

Method

Subjects

Aviation psychologists from Canada, Denmark, the Netherlands, Norway, the United Kingdom, and the United States served as subject matter experts (SMEs). Their expert knowledge of the targeted pilot characteristics, testing issues (i.e., reliability, validity, interpretability), and the candidate selection instruments were crucial for identifying the most promising selection instruments for inclusion in a computer-based fighter pilot test battery.

Procedure

Study 1 focused on determining important fighter pilot characteristics like cognitive and perceptual-motor abilities (e.g., memorization, psychomotor coordination) and personality constructs (e.g., achievement motivation, risk-taking). Study 2 focused on identifying selection instruments that could be used to measure individual differences in the 12 most important abilities. The identification of suitable measures of important personality constructs was set aside as a separate task.

Before the selection instrument review could begin, it was necessary to gather information about the test characteristics of potential selection instruments (i.e., those currently in use in the national pilot selection programs). Aviation psychologists from each participating country were requested to document national pilot selection instruments using a structured format which included information regarding general characteristics (e.g., title, publisher), technical characteristics (e.g., number of items, scoring procedure), administration of the test, psychological data (e.g., theoretical basis), technical evaluation (e.g., norms, reliability, validity), references, and a summary evaluation. For additional details see Appendix C.

The test review board, which consisted of aviation psychologists from Canada, Denmark, the Netherlands, Norway, the United Kingdom, and the United States, considered several factors when reviewing the candidate selection instruments. Tests were judged for ease of programmability, dimensionality (i.e., does test measure one or more than one attribute), scoreability/interpretability, validity, culture fairness, and other factors. Table 2 provides a complete list of the factors considered. Some of the factors listed in Table 2 could cause a test to be rejected without consideration of other factors (e.g., lack of copyright ownership, lack of culture fairness, non-programmable). Tests that were judged to meet the minimum requirements for inclusion were compared in greater detail. For example, short tests generally were considered more desirable than long tests with similar programming requirements and validity.

TABLE 2. FACTORS USED TO ASSESS TEST SUITABILITY FOR INCLUSION IN THE ACSWG TEST BATTERY

1.	Programmability
2.	Dimensionality
3.	Advantage of computer over paper-and-pencil administration
4.	Scoreability/Interpretability
5.	Data reduction complexity
6.	Test length
7.	Construct and predictive validity
8.	Culture fairness
9.	Number of countries where test is currently in use
10.	Copyright ownership
11.	Machine or system dependency
12.	Aptitude (rather than achievement) test
13.	Uniqueness of test (i.e., is test the same as others being considered)

Results

Ninety Seven (97) tests from nine countries were evaluated. A summary of the evaluations including the test name, abilities measured, country identification code, and suitability decision are summarized in Appendix D. When a test was judged to be unsuitable for further consideration, the factor(s) related to this decision were noted. For example, BE2 (Reasoning Test) was judged to lack culture fairness, NO13 (Mirror Tracing) was not programmable, and US6 (Time Sharing) was too long.

The 21 tests judged to be suitable for inclusion in the computer-based test battery are listed in Appendix E. The targeted test battery length was two hours. As it was neither feasible nor desirable to include all of these in the test battery, they were further scrutinized to identify those with the greatest potential. The 21 tests were evaluated in terms of the abilities measured, ease of programmability, predictive validity, and test length. The final recommended tests are summarized in Table 3. Individual test descriptions are presented in Appendix F.

TABLE 3. AIRCREW SELECTION WORKING GROUP FIGHTER PILOT TEST BATTERY SUMMARY

	Test Name	Length (mins)	Attribute Measured	Types of Scores
1.	Test Battery Introduction	10	Biographical information	Age, gender, previous flying experience
2.	Vigilance	10	Situational awareness, time-sharing, divided attention	Number of routine tasks, number of priority tasks, response time on priority tasks
3.	Matrices	15	Reasoning (nonverbal)	Response time, response accuracy
4.	Digit Recall	5	Memorization	Response time, response accuracy, weighted accuracy score
5.	Complex Coordination	10	Time-sharing, psychomotor coordination (compensatory tracking)	Tracking error
6.	Instrument Comprehension	20	Reasoning, visualization	Response time, response accuracy
7.	Time-Sharing 2	15	Time-sharing, divided attention, control precision	Tracking difficulty, response time, response accuracy
8.	Scheduling 2	6	Situational awareness, time sharing, divided attention	Number of points accumulated
9.	DTG	20	Selective attention, response orientation	Response accuracy

No tests of selective attention or response orientation suitable for computer-based administration without customized keypads or peripheral devices were identified. The SMEs recommended that the ACSWG consider leasing or acquiring specialized equipment to host tests measuring selective attention and response orientation (e.g., *Determinations Geraet* or DTG test device).

CONCLUSION

The ACSWG adopted the recommendations of the SMEs for the development of a computer-based fighter pilot selection battery. The ACSWG subsequently forwarded this information to the Air Force Subgroup (AFSG) which oversees ENJJPT. The ACSWG then requested and was granted AFSG permission to validate the recommended test battery against ENJJPT performance criteria.

The ACSWG fighter pilot selection battery was programmed on modified Portable Basic Attributes Test systems (i.e., PortaBAT; see Carretta, 1987 for a description). Rudder pedals on loan from the UK were added for use in the Complex Coordination test. As the modified PortaBAT systems were not suitable for administering tests of selective attention or response orientation, the ACSWG acquired two DTG systems (on loan from Dr Schufried) to measure these abilities.

Six PortaBAT systems are on loan from the US Air Force to the ACSWG for use during the fighter pilot test battery validation. Test instructions have been programmed in English, Italian, Portuguese, Spanish, and Turkish to accommodate national testing requirements. Test battery validation is expected to be completed in Fall 1994.

REFERENCES

Aircrew Selection Working Group (1983). *Answers to national questionnaire of aircrew selection.* Unpublished manuscript.

Aircrew Selection Working Group (1987). *Proceedings of the Seventh Meeting of the Euro-NATO Aircrew Selection Working Group.* Toronto, Canada.

Aircrew Selection Working Group (1988). *Aircrew selection and classification test descriptions.* Unpublished manuscript.

Levine, N.G., Mallamad, M.S. & Fleishman, A.E. (1978). *Decision aids in estimating personnel requirements.* Washington, D.C.: Advanced Research Resources Organizatedion.

Carretta, T.R. (1987). *Basic Attributes Test (BAT) system: Development of an automated test battery for pilot selection* (AFHRL-TR-87-9. Brooks AFB, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

McAnulty, D.M. (1987). *The selection of ability test constructs for predicting performance in initial helicopter training.* Paper presented at the Seventh Meeting of the Euro-NATO Aircrew Selection Working Group. Toronto, Canada.

Rodgers, M.N. & Sage, P.N. (1986). *Identification of ability requirements for NATO fast-jet pilot selection.* Technical Note 34/86. Willowdale, Ontario: Canadian Forces Personnel Applied Research Unit.

APPENDIX A

DEFINITIONS OF CHARACTERISTICS USED IN FIGHTER PILOT TASK ANALYSIS

APPENDIX A

DEFINITIONS OF CHARACTERISTICS USED IN FIGHTER PILOT TASK ANALYSIS

ORAL COMPREHENSION: The ability to understand spoken English words and sentences.

WRITTEN COMPREHENSION: The ability to understand written sentences and paragraphs.

ORAL EXPRESSION: The ability to use English words or sentences in speaking so others will understand.

WRITTEN EXPRESSION: The ability to use English words or sentences in writing so others will understand.

MEMORIZATION: The ability to remember information, such as words, numbers, pictures, and procedures. Bits of information can be remembered by themselves or with other pieces of information.

SITUATIONAL AWARENESS: The state of constant mental readiness in order to respond to situational changes.

REASONING: The ability to combine separate bits of information and to apply general rules in order to derive logical answers or form conclusions.

INFORMATION ORDERING: The ability to correctly follow a rule or set of rules to arrange things or actions in a certain order. The rule or set of rules used must be given. The things or actions to be put in order can include numbers, letters, words, pictures, sentences, and mathematical or logical operations.

NUMBER FACILITY: Involves the degree to which adding, subtracting, multiplying, and dividing can be done quickly and correctly. These can be steps in other operations like finding percentages.

DIVIDED ATTENTION: The ability to shift back and forth between two or more sources of information.

FLEXIBILITY OF CLOSURE: The ability to identify relevant information in a complex perceptual field.

TIME SHARING: The ability to observe several sources of information, actions or tasks at the same time, to combine them, allot task priorities, and integrate them into actions that have to be performed.

SELECTIVE ATTENTION: The ability to concentrate on the task one is doing.

PERCEPTUAL SPEED: The ability to perceive quickly and accurately even small details in patterns and configurations.

SPATIAL ORIENTATION: The ability to tell where you are in relation to the location of some object or tell where the object is in relation to you.

VISUALIZATION: The ability to imagine the movement of objects in three dimensional space.

PSYCHOMOTOR COORDINATION: The ability to coordinate movements of two or more limbs, such as in moving equipment controls. Two or more limbs are in motion while the individual is sitting, standing, or lying down.

CONTROL PRECISION: The ability to move controls of a machine or vehicle. This involves the degree to which these controls can be moved quickly and repeatedly to exact positions.

RATE CONTROL: The ability to adjust an equipment control in response to changes in the speed and/or directions of a continuously moving object or scene. The ability does not extend to situations in which both the speed and direction of the object are perfectly predictable.

RESPONSE ORIENTATION: The ability to choose between two or more movements quickly and accurately when two or more different signals (light, sounds, pictures) are given. The ability is concerned with the speed with which the right response can be started with the hand, foot, or other parts of the body.

AGGRESSIVENESS: The ability to decide rapidly on an adequate appropriate action and to carry it out immediately.

RISK TAKING: Willingness to take bold decisions based on an adequate cognition of dangerous situations. Not possessing a defensively cautious attitude.

ASSERTIVENESS: Belief in one's own capabilities. Self-assured and possessing a willingness to defend one's own opinions.

EMOTIONAL STABILITY: Emotionally mature, stable, and having few neurotic symptoms.

COOPERATIVENESS: Willingness to cooperate with other people.

LEADERSHIP: The ability to lead others based on personal behavior, authority, and the ability to convince others. Personnel management skills.

ACHIEVEMENT MOTIVATION: Willingness and determination to work towards goals.

APPENDIX B

CRITICAL FIGHTER PILOT TASKS

APPENDIX B

CRITICAL FIGHTER PILOT TASKS

1. Perform systems/weapons checks.
2. Manage on-board systems.
3. Set up attack.
4. Perform tactical offensive flight maneuvers.
5. Avoid, evade or suppress threats.
6. Monitor and control flight parameters.
7. Perform weapons delivery.
8. Perform formation tactics.
9. Respond to aircraft emergency situations.
10. Manage communications.
11. Perform low level navigation.
12. Perform tactical defensive flight maneuvers.

APPENDIX C

STANDARDIZED TEST DESCRIPTION FORM

APPENDIX C

STANDARDIZED TEST DESCRIPTION FORM

1.0 General Characteristics

- 1.1 Title of test
- 1.2 Author
- 1.3 Publisher
- 1.4 Complementary materials
- 1.5 Country of origin
- 1.6 Language of origin
- 1.7 Other language versions

2.0 Technical Characteristics

- 2.1 Number of items
  - 2.1.1 Item type
- 2.2 Administration mode
- 2.3 Time required to administer test
- 2.4 Scoring procedure
- 2.5 Time required to score or interpret test
- 2.6 Examiner qualifications
- 2.7 Type of test
- 2.8 Subtests
- 2.9 Parallel Forms
- 2.10 Age groups

3.0 Admninistration of the test

- 3.1 Facilities
- 3.2 Material
- 3.3 Directions

4.0 Psychological Data

- 4.1 Theoretical basis
- 4.2 Nature of content

5.0 Technical Evaluation

- 5.1 Norms
  - 5.1.1 Type
  - 5.1.2 Standardization Sample
- 5.2 Reliability
  - 5.2.1 Types of procedures
  - 5.2.2 Scorer reliability
  - 5.2.3 Equivalence of forms
  - 5.2.4 Long-term stability
- 5.3 Validity
  - 5.3.1 Types of validation procedures used
  - 5.3.2 Specific procedures followed in assessing validity and results obtained
  - 5.3.3 Size and nature of validation sample

6.0 References - list of studies related to test

7.0 Summary of Evaluation-Strengths and weaknesses of the test

APPENDIX D

TESTS CONSIDERED FOR INCLUSION IN ACSWG FIGHTER PILOT TEST BATTERY

APPENDIX D

TESTS CONSIDERED FOR INCLUSION IN ACSWG FIGHTER PILOT TEST BATTERY

Test Name	Country	Abilities Measured[1] 1 2 3 4 5 6 7 8 9 10 11 12	Decision[2] & Reason
Instrument Comprehension	BE1	* * * *	Y
Reasoning Rennes	BE2	*	N-8
Mechanical Comprehension	BE3	* *	N-12
Map Reading BAF304	BE4	* *	N-12
Coordination Test	BE5	*	Y
Reaction Meter Type 318	BE6	*	N-1,11
PICAR	BE7	* * * * * * * * *	N-11
Determination Gerat DTG	BE8	* * * * * *	N-1,10,11
Two Hand Coordination	US1	*	Y
Complex Coordination	US2	* *	Y
Mental Rotation	US3	*	Y
Item Recognition	US4	*	Y
Immediate/Delayed Memory	US5	*	N-7
Time Sharing	US6	* *	N-6
Vigilance	US7	*	Y
Scanning and Allocation	US8	* * * *	Y
Manikin	US9	*	Y
Pattern Recognition	US10	*	N-7
Scheduling	US11	* *	N-7
Serial Mental Arithmetic	US12	*	N-12
Kinesthetic Memory	US13	* *	N-4
Anticipation	US14	*	N-7
Persistance	US15	* *	N-7
Instrument Comprehension	US16	* *	Y
Time Sharing II	US17	* * *	Y
Perceptual Speed II	US18	*	Y
3D Mental Rotation	US19	*	Y
ABCD Working Memory	US20	* *	N-7,8
Inst Coord Analyser	GE1	* * * * *	N-1,6,11
Sensory Motor Test	GE2	*	Y

Test Name	Country	Abilities Measured[1] 1 2 3 4 5 6 7 8 9 10 11 12	Decision[2] & Reason
LGT3	GE3	*	N-6.10
KBT	GE4	*	N-1
TVT Technical Comprehension	GE5	*	N-12
Digit Search Test	GE6	*	Y
Labyrinth	GE7	*	N-1
Road Figure Test	GE8	*	N-7
Culture Fair IQ Test	GE9	*	N-10.8
ABC-1 Logical Reasoning	UK1	*	N-8
ABC-2 Logical Reasoning	UK2	* * *	N-8
Angles Bearings Degrees	UK3	*	N-7
Visual Search	UK4	*	Y
Dual Task	UK5	* *	N-13(US17)
Manikin	UK6	*	N-13(US9)
Vigilance	UK7	* *	N-13(US7)
Digit Recall	UK8	*	Y
Digit Recognition	UK9	*	N-13(UK7)
Annett Handedness	UK10	*	N-7
Time Sharing	UK11	* * * * *	Y
Visualization	UK12	*	N-13(US19)
Cubes	UK13	*	N-7
Ravens Adv Prog Matrices	UK14	*	N-10
Sensory Motor Apparatus	UK15	*	N-13(BE5)
Control of Velocity	UK16	*	Y
Instrument Comprehension	UK17	* * *	N-13(BE1)
Mathematics MATAB2	UK18	*	N-12
TSM Matrices	NO1	*	Y
Number Series	NO2	*	N-6
Mechanical Comprehension	NO3	*	N-12
Pattern Comprehension	NO4	*	N-10
Figure Pattern	NO5	*	Y
Figure Form	NO6	* *	N-13(US3)
Time Estimation & Blocks	NO7	* *	N-7
Sorting Test	NO8	* *	N-1

Test Name	Country	Abilities Measured[1] 1 2 3 4 5 6 7 8 9 10 11 12	Decision[2] & Reason
Direction Reversal	NO9		N-1
Number Counting	NO10		N-13(GE6)
Instrument Comprehension	NO11		N-13(BE1)
Space	NO12		N-7
Mirror Tracing	NO13		N-1
Memory Test	NO14		N-7
Instrument Reading WC2	CA1		N-13(BE1)
Serial Addition AS2	CA2		N-12
Vis Gen Aviat VGAT	CA3		N-11
General Classification	CA4		N-8
Table Reading WT2	CA5		N-1
Instrument Reading WI2	CA6		N-7
Verbal Aptitude TV2	CA7		N-8
Maths Reasoning AR2	CA8		N-7,12
Auto Pilot Sel Sym CAPSS	CA9		N-11
D48 Matrices	IT1		N-10
Deux Barrage	IT2		N-10
GATB-3 Object Comparison	NE1		N-10
GATB-5 Form Comparison	NE2		N-10
GATB-7 Perceptual Speed	NE3		N-10
Berenachot G Test	NE4		N-8,10
VMA Aircraft Manoeuvres	NE5		Y
Sensory Motor Apparatus	NE6		N-13
RBT Radar Display Test	NE7		N-7
Instrument Interpretation	NE8		N-13(BE1)
SVK Heading Estimation	NE9		N-7
Rudder Control Test	NE10		N-11
Complex Coordination	NE11		N-11,1
DTG-3	NE12		N-11,10,1
Raven Matrices	DK1		N-10
IDP-53	DK2		N-8
Mechanical Comprehension	DK3		N-10
PIT	DK4		N-13(NL5)

Test Name	Country	Abilities Measured[1] 1 2 3 4 5 6 7 8 9 10 11 12	Decision[2] & Reason
SIMCAP	DK5	•	N-1

Notes

[1]Ability Names

1. Situational Awareness
2. Memorization
3. Reasoning
4. Perceptual Speed
5. Time Sharing
6. Selective Attention
7. Response Orientation
8. Spatial Orientation
9. Divided Attention
10. Psychomotor Coordination
11. Control Precision
12. Visualization

[2]See Table 2 for an explanation of "reason for non-suitability."

APPENDIX E

TESTS SUITABLE FOR INCLUSION IN ACSWG FIGHTER PILOT TEST BATTERY

APPENDIX E

TESTS SUITABLE FOR INCLUSION IN ACSWG FIGHTER PILOT TEST BATTERY

Country and ID Code									Ability Measured											
DK	GE	BE	UK	NO	NL	CA	US	Test Name	1	2	3	4	5	6	7	8	9	10	11	12
		1	17	11	8	1	6	Instrument Comprehension			*	*				*				*
		5	15		6			Sensory Motor Apparatus										*		
							1	Two Hand Coordination										*		
							2	Complex Coordination					*					*		
				6			3	Mental Rotation												*
							4	Item Recognition		*										
			7				7	Vigilance	*											
							8	Scanning & Allocation	*				*				*		*	
			6				9	Manikin								*				
	2							Sensory Motor Test									*	*		
	6			10				Digit Search Test				*								
			5				17	Time Sharing 2					*				*		*	
							18	Perceptual Speed 2				*								
			12				19	Mental Rotation												*
			4					Visual Search				*								
			8					Digit Recall		*										
			11					Scheduling	*	*			*				*			
			16					Control of Velocity										*		
				1				TSM Matrices			*									
				5				Figure Pattern				*								
4					5			VMA Aircraft Manoeuvres								*				

APPENDIX F

ACSWG TEST BATTERY DESCRIPTIONS

APPENDIX F

ACSWG TEST BATTERY DESCRIPTIONS

Test Battery Introduction

This interactive subprogram prompts the subject to provide background information (e.g., identity, age, gender) as well as previous flying experience.

Vigilance

A 9 block grid appears on the screen. The numbers along the left side of the grid are the "A" coordinates and correspond to the rows. The numbers along the top of the grid are "B" coordinates and correspond to the columns. Each block in the grid can be identified by its row and column coordinates.

During the test, asterisks, "*" appear within the blocks of the grid. The subject's "routine task" is to cancel these asterisks as quickly as possible. An asterisk is canceled (i.e., erased) by entering its row and column coordinates on the keypad.

In addition to the asterisks, arrows "^" may appear in the blocks of the grid. These arrows represent an "emergency task." The subject is instructed to respond as quickly as possible when an arrow (i.e., emergency) appears. This function is done by pressing the ENABLE key, then entering the row and column coordinates of the arrow (i.e., emergency). The subject is instructed to resume performing the routine task (i.e., canceling asterisks), when no arrows are present.

The measure of interest for this test are the number of routine and emergency tasks successfully completed and the average response time required to complete emergency tasks.

The psychological factors assessed by this test include situational awareness, time sharing, and divided attention. The test requires about 10 min to complete.

Matrices

In the Matrices test, a picture of an incomplete geometric pattern appears on the screen. (The lower right-hand corner of the pattern is missing). The subject's task is to choose from several alternatives, which would correctly complete the pattern. The subject indicates his/her choice by entering the number of the chosen alternative on the response keypad.

The first 6 items are for the practice only. The remaining 30 items are test items and are scored. In this test and in the Instrument Comprehension test (see below), the subject may go backwards and forwards through the test. The subject has the option to skip items, to review the items previously answered or skipped, and to change answers. This test has a 10-min time limit that begins when the subject starts the first test item (i.e., review of instructions and practice items are not timed). Response speed and accuracy are recorded on each item.

The Matrices test assesses non-verbal reasoning and requires about 15 min to complete.

Digit Recall

In this test, a number string appears on the screen. After a few seconds, the number string is removed from the screen and is replaced by a string of empty boxes. (The number of boxes is equal to the number of numbers in the string). The subject's task is to enter the number string into the boxes.

The length of the strings vary from 7 to 12 numbers. Response time and response accuracy are recorded on each of the 30 test items. Response accuracy is calculated in 3 ways for each item: (1) correct or incorrect, (2) number of numbers placed in their correct position in the string, and (3) a weighted scoring algorithm that gives partial credit for numbers placed out of sequence.

This test measures short-term memory and requires about 10 min to complete.

Complex Coordination

The ACSWG Complex Coordination test is a variation of the USAF test with the same name. In this test, a dual-axis (right hand) control stick is used to control the horizontal and vertical movement of a cursor. Rudder pedals (instead of the left-hand control stick in the USAF version) are used to control the left-right movement of a vertical "rudder bar" of light at the base of the screen. The subject's task is to maintain the cursor (against a constant horizontal and vertical rate bias) centered on a large cross fixed at the center of the screen while simultaneously centering the rudder bar at the base of the screen (also against a constant rate bias). After receiving instructions, the subject completes a 3-min practice session and a 5-min test. The Complex Coordination test assesses psychomotor coordination and time sharing ability (i.e., compensatory tracking ability involving multiple axes) and requires about 10 min to complete.

Instrument Comprehension

In this test, an illustration of an airplane in 5 different positions is shown on the screen. An artificial horizon indicator and a compass are displayed above these aircraft. The subject's task is to determine which of the aircraft agrees with the readings on the artificial horizontal indicator and compass. The subject indicates his/her choice on each item by pressing the numbered key that corresponds to the chosen alternative.

The test items begin after the subject has completed the instructions and practice items. As with the Matrices test (see above), the subject may go backwards and forwards through the test, and may skip items, review items previously answered or skipped, or change answers.

This test has 60 test items and a 15-min time limit that begins when the subject starts the first test item (i.e., review of instructions and practice items are not timed).

Response speed and response accuracy are recorded on each item. The instrument Comprehension test measures reasoning and visualization. Total test administration time, including instructions, practice, and test items is about 20 min.

Time-Sharing 2

Two distinctly different kinds of tasks are involved in this test. The first is a measure of hand-eye coordination and the second is a measure of attention.

The first three 1-min trials involve tracking only to provide a pure estimate of the subject's psychomotor coordination. During these trials, a "stationary image" of an aircraft and a "gunsight" that move to the left or right are displayed on the screen. The subject must maneuver the right-hand control stick to keep the gunsight centered on the airplane.

The next two 1-min trials involve detecting and responding to missing numbers. The numbers appear one at a time in sequence on the lower part of the screen. The number sequence is 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, etc. Occasionally a number will be missing from the sequence (e.g., 0, 1, 2, 3, 4, 6, 7, ...[5 is missing]). The subject's task is to type the missing number on the response keypad. Subjects are scored on both response speed and accuracy.

The final 5 1-min trials involve both tracking and missing digits. While the subject is maneuvering the right-hand control stick to keep the gunsight on the airplane, he/she also must monitor the number counter in order to be able to detect the missing numbers.

This test assesses the psychological factors of time-sharing, divided attention, and control precision. Test administration time is about 15 min.

Scheduling 2

In this test, the subject is presented with 5 horizontal scales that can range in value between 0 and 10 points. Each scale increases at a unique, constant rate. Each scale appears on a separate screen and may be viewed by entering the scale number on the response keypad. (1, 2, 3, 4, or 5). The subject "scores" points equal to the current value of the displayed scale by pressing the ENABLE key. When the ENABLE key is pressed, the current value of the displayed scale is added to the subject's total score and the scale is reset to 0 (where it will start incrementing again).

If the value of a scale reaches its upper limit, and the subject has not responded by pressing the ENABLE key, the value of the scale will return to 0 without the subject receiving any points for that scale.

The Scheduling 2 test measures the psychological constructs of situational awareness, time-sharing, and divided attention. This test requires about 6 min to complete.

Determinants Geraet

This test is hosted on the DTG test device rather than the Porta-BAT system. The subject's task is to respond as quickly and accurately as possible to auditory (i.e., high and low tones) and visual signals (i.e., colored lights) by pressing foot pedals and/or buttons. Subjects are presented with detailed instructions as to how to respond to different visual and auditory signals.

The test begins with several practice items that are neither timed nor scored. The purpose of the practice items is for the subject to learn the appropriate response to each stimulus.

After reviewing the instructions and completing the practice items, the subject is presented with a series of test items. The test consists of 5 groups of items. There are 150 items in Group 1 and 75 items in Group 2 through 5 (150 + 4 (75) = 450 items). As described earlier, during the practice items there is no time limit imposed on the subject. During the actual test, the subject must respond to items within a fixed limit. Failure to respond in time results in an item being scored as incorrect. The interstimulus interval is decreased in each successive group of test items, thus increasing task difficulty.

The scoring procedure for this test produces several response accuracy scores including the number of correct responses, number of nonresponses, number of delayed correct responses, and number of incorrect responses. The DTG test is designed to measure selective attention and response orientation. The instructions, practice and test items require about 20 min to complete.